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GROUP A STREPTOCOCCUS IN PETS AND GROUP A STREPTOCOCCAL DISEASE--ETC(U)

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GROUP A STREPTOCOCCUS IN PETS AND GROUP A
STREPTOCOCCAL DISEASE IN MAN

A Thesis

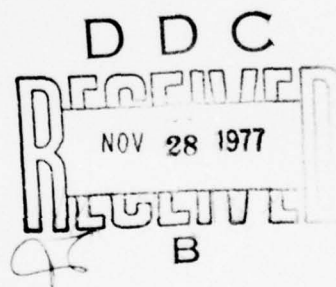
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for the Degree Master of Science

by

Harvey Raymond Crowder, D.V.M.

The Ohio State University
1977

Approved by



C. Richard Dorn
Adviser

Department of Veterinary
Preventive Medicine

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DEDICATION

To Chrissy and Steve, for making it all worthwhile.

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INTRODUCTION AND LITERATURE REVIEW

Streptococcal disease in human beings and animals has diverse manifestations and the pertinent scientific literature is very extensive. This review will concentrate on the literature describing characteristics of the agent, its classification, clinical observations and especially the epidemiology of streptococcal disease in man and his pets.

There are several excellent review articles and books which summarize various facets of the extensive subject of the streptococci. The subject of antigenic and chemical characteristics of the streptococcal cell wall is reviewed by Rosan in *The Analytical Serology of the Streptococci and the Lactobacilli* and by McCarty in *The Streptococcal Cell Wall*. (58,40) Williams, Moody, and Youmans et al. provide excellent sources of useful information on laboratory diagnosis. (74,42,75) McCarty and Rammelkamp and Top offer valuable information on the human disease spectrum. (39,56) The epidemiology of streptococcal upper respiratory infections in human beings has been presented by Wannamaker and by Rammelkamp. (71,55) Two books which cover a large range of subjects on the streptococci and streptococcal diseases are Streptococcal Infection edited by McCarty and Streptococci and Streptococcal Diseases: Understanding,

Recognition, Management edited by Wannamaker and Matsen. (38,72) A discussion of streptococcal zoonosis by Fluharty is found in Diseases Transmitted from Animals to Man edited by Hubbert et al.. (14)

The classification of the streptococci into various groups has been of interest for quite some period of time. One of the earliest attempts at classification was the work of Schottmüller which divided the streptococci into strains based upon their ability to hemolyse red blood cells. (59) Dochez et al. described a method of identifying serological groups of human streptococci using agglutination and mouse protection tests. (8) Further serological classification of human streptococci was developed by Griffith (1926,1927,1934) and by Lancefield (1928). (17,18,19,28) A technique for the differentiation of groups of streptococci from different species of animals was developed by Lancefield in 1933, using a precipitin test similar to one developed by her for the typing of human strains of Streptococcus. (29) This study provided evidence that streptococci from one species tended to fall into one group of streptococci, i.e.; most human β -hemolytic streptococci were classified as Group A, those from bovine and dairy sources were classified as Group B. The original paper only described Groups A through E; however, Lancefield's grouping has now been expanded to include Groups A through H and K

through P. (75) The type specific protein (M protein) for typing streptococci of human origin (Group A Streptococcus), originally described by Lancefield in 1928, was found not to be present in all Group A Streptococcus. (28,30,37,69) By using Griffith's slide agglutination method of typing Group A Streptococcus most strains of Group A could be typed. (37,69) Because of the inability to type certain strains of Group A Streptococcus by Lancefield's precipitin technique, other antigens in the streptococcal cell wall were sought.

The presence of another antigen in the Group A streptococcal cell wall was discovered by Lancefield in 1940. (31) Designated the T antigen, it was found to be one of the major antigens of the cell and was responsible for the cross reactions observed using Griffith's slide agglutination technique. Another antigenic component of the Group A streptococcal cell wall, the R antigen, was found by Lancefield and Pearlman in 1952. (32) This protein has been found in some types of Group A and in certain other groups of streptococci. Of the 3 major antigen systems described for Group A Streptococcus, the M and T protein are presently the most commonly used systems for the typing of Group A streptococci. These antigens are of special importance in studying the epidemiology of diseases caused by

Group A streptococci. (75)

Maxted, in 1953, developed a method of differentiating Group A Streptococcus from other groups of streptococci by the use of bacitracin. (36) This method has provided a rapid low cost method for the presumptive diagnosis of Group A streptococcal infection. (42) Moody et al., in 1958, described a technique of identification of the groups of streptococci by the use of fluorescence microscopy. (43) This method provides relatively rapid results and can be adapted to process relatively large numbers of isolates in a short period of time. (42) Another method of grouping streptococci is by co-agglutination with sensitized Staphylococcus, described by Edwards and Larson, this provides a means of grouping streptococci directly upon the agar plate. (11) Edwards and Larson have also described a modification of serological grouping of streptococci by using counter-immunoelectrophoresis. (10) Skjold and Wannamaker have recently described a method for sub-typing M type 49 Group A streptococci using phage which could be applied to other types of streptococci of epidemiological interest. (60)

The diseases of human beings caused by the streptococci can be divided into 2 basic classifications. The first are the acute suppurative infections and the

second are the non-suppurative sequellae of these infections. Acute diseases associated with Group A streptococci include: tonsillitis-pharyngitis, pyoderma, and septicemia. (39,56,75) Complications of these diseases usually occur in the form of extension of the infection into other tissues or abscessation. Scarlet fever is a common sequellae of Group A streptococcal infection and is a result of the erythrogenic toxin which is released from the Group A streptococci. The delayed sequella of streptococcal infection include acute glomerulonephritis and rheumatic fever. Rheumatic fever occurs at various lengths of time following the onset of acute streptococcal sore throat and seems to be associated with all types of Group A streptococci. (39,56) Acute glomerulonephritis is associated with certain types of Group A streptococci which can be of respiratory or dermal origin.

The streptococci have been incriminated in causing many diseases in pets. They have been associated with myositis, isolated from animals with tracheobronchitis, pyothorax and mediastinal abscesses, bacterial endocarditis, acute prostatitis, and bacterial cystitis, (5,2,33,53,65,73,68,13,16,46)

β -hemolytic streptococci have also been found among the normal flora of the canine oro-pharynx and nasal cavities. (3,6,33,61) Smith and Brennan and Simkins

found that Group G predominated as the most common Lancefield's group of β -hemolytic streptococci. (61,3) Smith also found Groups C, L, and M. Laughton found that Group M predominated in healthy dogs while Groups G and L were most common in puppies dying shortly after birth. (33) Clapper and Meade found β -hemolytic streptococci in dogs within an open laboratory colony and among these β -hemolytic streptococci they found a 9% prevalence of Group A Streptococcus from the specimens derived from throat swabs. (6) Kurek and Rutkowiak in an attempt to isolate Streptococcus pyogenes found a 7% prevalence rate of Group A Streptococcus in dogs from households within an urban environment. (27) Peterson made the observation that isolations of Group A Streptococcus seemed to occur in pets from households with streptococcal upper respiratory infections more often than in households without streptococcal disease. (49)

The epidemiology of streptococcal upper respiratory diseases in man has been widely studied. Streptococci are maintained in the environment by human carriers which harbor organisms in the lymphoid tissues of the upper respiratory tract. (55) These carriers shed viable streptococci for various and sometimes lengthy periods of time after recovery from acute streptococcal upper respiratory tract disease. (25) Carriers of β -

hemolytic streptococci shed organisms through both oral and nasal secretions; however, carriers actively shedding streptococci through the nasal passages more effectively spread viable streptococcal organisms. (20,21,71) As the duration of the carrier state increases, the number of β -hemolytic streptococci decreases as does the ability of the carrier to transmit disease. (25,55,71) This decreasing ability to transmit disease is associated with a decreasing ability to produce M protein as the length of the carrier state increases. (55) Reports of the prevalence of carriers of β -hemolytic Group A Streptococcus vary widely depending upon the location of the survey and the population surveyed. Children have the highest carrier rates with rates reported as low as 4% by Quinn and as high as 38% by Cornfield and Hubbard. (54,7) Nicholas and Steele and Pike and Fashena have reported carrier rates in the 15 to 30% range for children also. (45,52) The carrier rates of Group A Streptococcus for adults are lower with one report being around 2%. (67) A generally accepted figure for the carrier rate of Group A Streptococcus for an entire population is around 10%. (41) Intimate contact is necessary for the transmission of Group A Streptococcus between individuals. Perry et al. and Srisuparbh and Sawyer have both shown that after as little as 24 hours Group A Streptococcus loses its

ability to produce disease while still remaining viable.
(47,48,63)

In general the isolation rate of β -hemolytic Group A Streptococcus seems to be highest among children, but streptococci can colonize all ages. (67) The carrier state is important in the maintenance of streptococcal disease in an area. Phibbs et al. and Frank et al. have shown that a reduction in the rate of isolation of Group A Streptococcus and diseases caused by streptococci can be achieved by a mass surveillance and treatment program. (50,15)

The epidemiology of streptococcal infection in pets has not been studied to the degree that it has in humans. Pilot et al. recognized that β -hemolytic streptococci were one cause of tonsillitis in dogs and that streptococci were secondary invaders in canine distemper. (53) They were also able to produce tonsillitis by inoculating the tonsils of experimental dogs with cultures of streptococci isolated from a dog who died from pneumonia; however, they failed to produce tonsillitis in dogs with strains of streptococci (group unspecified) isolated from human beings. Stafseth et al. (1937) isolated β -hemolytic streptococci of an unspecified Lancefield's group from dying puppies, the bitch that whelped the puppies, and the dog that serviced

the bitch, implying that sexual contact caused the spread of the organism. (65) Hare and Fry also observed a sterility and cervical adenitis syndrome in dogs which seemed to be associated with Lancefield's Groups G and L. (22,23) Stableforth isolated β -hemolytic streptococci from dogs associated with mastitis, dermatitis, and pneumonia but speculation as to the mode of the transmission was not given. (64) In 1940, Stafseth failed to experimentally reproduce disease in dogs injected with virulent streptococci. Stafseth noted that the streptococci isolated from previously noted diseases might have been secondary invaders, however, he did isolate streptococci from the tonsils of diseased puppies. (65) Laughton found streptococci in dogs from diseased kennels tended to be Groups G and L while streptococci isolated from healthy kennels were Group M. No method of transmission was proposed for the Group G and L organisms. (33) Montovani et al. found that a Group L Streptococcus which was isolated from aborting bitches was capable of reproducing similar conditions in experimentally exposed dogs. Transmission was thought to occur through prolonged contact with infected animals and not through sexual contact. (33)

There is little information on the upper respiratory aquisition of β -hemolytic streptococci by dogs. Pilot

et al. found that over 92% of normal dogs harbor β -hemolytic streptococci in their tonsils and Laughton found β -hemolytic streptococci (nearly all Group M) in the genital tract and tonsils of 70% of healthy dogs examined. (53,33) Binn et al. and Wilkens and Helland isolated β -hemolytic streptococci from dogs with "kennel cough" and noted it as normal flora which had acted as a secondary invader during this primarily viral infection. (2,73) Smith, Clapper and Meade, and Brennan and Simkins all noted β -hemolytic streptococci as part of the normal flora of the upper respiratory tract of dogs. (61,6,3) Kurek and Rutkowiak noted that β -hemolytic Group A Streptococcus was associated with acute angina in dogs but did not speculate as to the mode of transmission. (27) It should be noted here that the Lancefield's grouping of the streptococci involved in some of the earlier studies of streptococcal diseases of the dog was not accomplished.

It has been shown that the dog can act as a host for human upper respiratory viruses. Lundgren et al. found antibodies to several human respiratory viruses in dogs (Para-influenza, Reovirus, Influenza, and Adenoviruses), showing that respiratory exposure to human viral pathogens can cause serologic responses

in the dog. (54) Ado and Titova and Todd and Cohen have shown that human type A influenza viruses will cause upper respiratory disease in dogs, however, this human pathogen could not be transmitted to contact dogs. (1,70)

Because dogs do serve as a reservoir of certain human pathogens and the isolation of Group A Streptococcus from dogs in households with human upper respiratory illnesses due to Group A Streptococcus, this investigation of possible zoonotic transmission of Group A Streptococcus was undertaken. The main purpose of this study was to determine if there was an increased prevalence, based upon bacterial isolation, of Group A Streptococcus in pets from households with streptococcal upper respiratory tract disease as compared to households without streptococcal disease.

MATERIALS AND METHODS

All households with pets that were swabbed for the presence of Group A Streptococcus were located in the vicinity of Dayton, Ohio. The samples were obtained between January 1977 and June 1977 at the Base Veterinary Services, Wright - Patterson Air Force Base, (W-P AFB) Ohio 45433.

Index households were defined as households in which at least one member of the household had been diagnosed by the USAF Medical Center, W-P AFB as having a Group A streptococcal infection at least once. Residents of the index households were asked by the attending medical staff to take their pets to the Base Veterinary Services, W-P AFB for bacteriologic examination to determine if Group A Streptococcus could be isolated from the pet's oro-pharyngeal region.

The swabbing of the index household's pets was accomplished by personnel from the Base Veterinary Services. A sterile rayon swab (a.) was vigorously rubbed over the oro-pharyngeal region of the pet. The swab was replaced in the supplied plastic tube with Modified Stuart's Bacterial Transport Medium and was taken by a member of the index household to the Laboratory, USAF Medical Center, W-P AFB.

a. Culturette , Scientific Products

The laboratory uses the method of Maxted for the identification of Group A Streptococcus. (36) When the swabs were received at the laboratory they were streaked on one half of a 5% sheep blood agar plate and a bacitracin differentiation disk for the identification of Group A Streptococcus (b.) was placed on the streaked area of the agar. To provide an environment which would help prevent the overgrowth of other organisms common to the oro-pharyngeal region a glass coverslip was placed next to the bacitracin disk. The blood agar plates were incubated at 37° C. for 18 to 24 hours and observed for the inhibition of growth and hemolysis around the bacitracin disk characteristic of Group A Streptococcus. Positive and negative results were reported back to the Base Veterinary Services where they were recorded.

Comparison households were households from which pets were submitted for routine vaccination (Canine Distemper, Hepatitis, Leptospirosis, Para-influenza, abies, Feline Panleukopenia, Feline Viral Rhinotracheitis, and Feline Calicivirus vaccines) at the Base Veterinary Services, W-P AFB. Only the households with residents that had been free from any detectable upper respiratory tract illness for at least 30 days prior to examination for vaccination were considered as comparison households.

b. Taxo A , BBL

Health status of each household was determined by clinical histories taken at the time of examination. Seventy six households involving 108 pets were eliminated from the study due to illness in the household: 54 households for colds and "flu", 11 for confirmed streptococcal disease, 11 for miscellaneous diseases, and 7 because no clinical history was completed. The remaining 180 households had a history of no clinical disease within the previous month.

The oro-pharyngeal region of the pets from comparison households was swabbed using a sterile rayon swab as described for pets from index households. Within 4 hours after collection the swabs were processed for streptococcal isolation in the same manner described for swabs from index households in the laboratory of the Department of Veterinary Preventive Medicine, the Ohio State University. Two different manufacturer's bacitracin disks were used at different times during the study. (b.,c.) The blood agar plates were incubated at 37° C. and observed for 12 to 24 hours for the inhibition of growth and hemolysis indicative of Group A Streptococcus.

-
- b. Taxo A , BBL
 - c. Bacto Differentiation Disks - Bacitracin , Difco.

Isolates were confirmed as Group A by Lancefield's capillary precipitation technique. (30) Suspected isolates were incubated in 40 ml of Todd-Hewitt broth (d.) overnight at 37° C.. The antigen was extracted from the streptococcal cell wall using the autoclave method of Rantz and Randall. (57) The overnight growth was centrifuged at 250 X G for 15 minutes to pellet the cells, the supernate discarded and the cells re-suspended in 0.5 ml normal saline. The streptococcal suspension was autoclaved 15 minutes at 20 pounds of pressure. The suspension was re-centrifuged and the supernate drawn into a capillary tube. An equal amount of Group A Streptococcus anti-serum (e.) was drawn up into the capillary tube and the tube placed in a verticle position in a clay block. The capillary tube was observed continuously for 1 hour for the formation of a precipitate. A positive control for Group A Streptococcus antigen (f.) was tested at the same time. One isolate which was not identified as Group A by this method was excluded from the results.

At the time that the oro-pharyngeal swabs were taken from pets of the index and comparison households, the pet owners were asked to complete a clinical history

-
- d. Bacto Todd-Hewitt Broth , Difco.
 - e. Bacto Streptococcus Anti-sera - Group A , Difco.
 - f. Bacto Streptococcus Antigen - Group A , Difco.

form containing questions about the pets and health of the household members. The format of the clinical history is shown in Figure 1. Index households which did not complete a clinical history during the study were followed up with a telephone interview to obtain the clinical history at the end of the study.

To attempt to corroborate the results of the Laboratory, USAF Medical Center, W-P AFB and those of the Department of Veterinary Preventive Medicine, selected specimens were submitted to both laboratories. At the beginning of the study a blood agar plate which was classified as positive for Group A Streptococcus and a negative plate were obtained from the Laboratory, USAF Medical Center, W-P AFB and colonies from these were replated and bacteriologically examined at the Department of Veterinary Preventive Medicine. Five paired swabs were submitted to both laboratories during this study and 3 samples which were identified as positive for Group A Streptococcus at the Department of Veterinary Preventive Medicine were submitted to the Laboratory, USAF Medical Center, W-P AFB for bacteriologic examination.

ANALYSIS OF DATA

The distributions of the species and sex of pets, the age of household members, and the prevalence of Group A Streptococcus in the index and comparison households were tested for significance using a Chi-square test for independence. The differences in the means of the age of pets, number of pets per household, and the number of people per household were tested for significance using a t test for the means of 2 populations with variances not equal. The tests of significance for the data were analysed at the 5% level.

CLINICAL HISTORY

7. How many visits have you and your pet made to a veterinarian in the last Year?

RESULTS

Between 1 January 1977 and 31 May 1977, 104 animals representing 80 index households were bacteriologically examined for the presence of Group A Streptococcus by the Base Veterinary Services, W-P AFB. During the same period of time 220 animals representing 180 comparison households were examined by the same methods for the presence of Group A Streptococcus at the Department of Veterinary Preventive Medicine.

INDEX HOUSEHOLDS

Clinical histories were completed for 62 (77.5%) of the 80 index households. These histories represented 86 (82.6%) of the 104 (77 dogs and 27 cats) animals in the index group. The species and sex distribution of pets from index households is presented in Table I. There was no significant difference in the species distribution of the pets from index and comparison households. There was a slight difference in the species and sex distribution of the two groups, which was not significant ($0.05 < p < 0.1$). The breed distribution of dogs from index households is given in Table II. The mean age of pets cultured from index

households was 4.15 ± 3.17 years with a range of 9 weeks to 13 years and a median age of 4 years. The mean number of pets in index household was 1.5 ± 0.68 with a range of 1 to 4 and a mode of 1 pet per household. There were 4.33 ± 1.13 people on the average in each index household. The family size ranged from 2 to 8 with a mode of 4 people per household. The age distribution of family members of index households is given in Table III. There was a significant difference in the age distribution of the index and comparison household's members ($p < 0.05$). The index households had a significantly greater ($p < 0.005$) percentage of children less than 15 years of age (44.5%) than did the comparison households (32%).

There were 3 index households, involving 3 pets, which were cultured and found positive for Group A Streptococcus. The data for these animals are presented in Table IV. The prevalence of Group A streptococcal isolation in index households was 3.75% (3/80). The prevalence of Group A streptococcal isolations in households with dogs was 4.22% (3/71). The overall prevalence of Group A Streptococcus isolation in all pets cultured from index households was 2.88% (3/104) and the prevalence of Group A streptococcal isolation in dogs alone was 3.89% (3/77).

COMPARISON HOUSEHOLDS

Three hundred twenty eight animals representing 256 comparison households were examined for the presence of Group A Streptococcus. Of these 256 households, 76 (representing 108 animals) were eliminated for previously stated reasons. The remaining 180 households with 220 animals were used for the comparison group. The species and sex distribution of comparison animals are given in Table I and the breed distribution of the dogs is given in Table II. The mean age of pets sampled from comparison households was 4.1 ± 3.3 years with a range of 8 weeks to 14 years and a median age of 2 years. The number of pets in the comparison households was 1.65 ± 1.0 with a range of 1 to 9 pets per household and a mode of 1 pet per household. The family size of the comparison household was 3.6 ± 1.57 people per household with a mode of 4 people per household. The age distribution of comparison households is given in Table III.

Five comparison households representing 6 animals were positive for Group A Streptococcus. The prevalence of Group A Streptococcus in comparison households was

2.97% (5/180). The prevalence of Group A streptococcal isolation from households with dogs was 2.79% (4/143) and the prevalence of isolation from households with cats was 2.17% (1/46). The prevalence, based on isolation, of Group A Streptococcus in all comparison pets was 2.72% (6/220). The prevalence of isolation from dogs alone was 3.08% (5/162) and from cats was 1.72% (1/58). Data for the 6 Group A Streptococcus positive pets from comparison households are given in Table V.

A summary of the index and comparison households is given in Table VI. Differences in the mean age of the pets from both index and comparison households were not statistically significant. The difference in the number of pets in the index and comparison households was different ($0.05 < p < 0.1$) but not significant; the difference in the number of people in the index and comparison households was significant ($p < 0.5$), the comparison households having more pets and the index households having more people.

GROUP A STREPTOCOCCUS ISOLATION

The comparison of the prevalence, based on isolation, of Group A Streptococcus in the 104 pets from the 80 index households and the 220 pets from the 180 comparison

households (2.88% in the index households and 2.72% in the comparison households) showed there was no significant difference in the prevalence of Group A Streptococcus between index and comparison household pets.

COMPARISON OF RESULTS FROM DIFFERENT LABORATORIES

The comparison of results between the Laboratory, USAF Medical Center, W-P AFB and the Department of Veterinary Preventive Medicine, the Ohio State University are shown in Table VII. The negative results of both laboratories compared well; however, none of the 3 Group A positive swabs submitted from the Department of Veterinary Preventive Medicine to the Laboratory, USAF Medical Center, W-P AFB were identified as positive for Group A Streptococcus by the latter facilities laboratory.

TABLE I

Sex and Species Distribution of 104 pets Sampled for Group A Streptococcus From Households with Human Streptococcal Infection and 220 Pets From Comparison Households.

	<u>Streptococcus Positive</u> (Index) Households	Comparison Households
Total Pets	104	220
Total Dogs	77	162
Male	26	73
Castrated Male	7	9
Female	17	54
Spayed Female	13	26
Undetermined	14	0
Total Cats	27	58
Male	7	13
Castrated Male	1	17
Female	4	11
Spayed Female	11	17
Undetermined	4	0

TABLE II

Breed Distribution of Dogs Sampled for Group A
Streptococcus in Households with Human Group A
Streptococcus Infection and in Comparison Households.

	Streptococcus Positive (Index) Households ¹	Comparison Households
Total Dogs	63	164
Poodle	11	15
Dachshund	2	14
German Shepard	3	8
Miniature Schnauzer	2	7
Cocker Spaniel	2	7
Shetland Sheepdog	2	4
Samoyed	0	4
Pomeranian	4	2
Basset Hound	2	1
Other Pure Bred Dogs ²	15	35
Mixed Breed Dogs	22	76

1. Results of 62 households for which clinical histories were obtained.
2. Individual breeds not listed because total households contained less than 3 dogs of one breed.

TABLE III

Age Distribution of Residents of 62 Group A
Streptococcus Positive (Index) Households and 180
Comparison Households.

Age	<u>Streptococcus Positive</u> <u>(Index) Households</u>		<u>Comparison</u> <u>Households</u>	
	Number	%	Number	%
Total	272	100	609	100
0-4 Years	26	9.6	40	6.6
5-10 Years	69	25.4	73	12.0
11-15 Years	26	9.6	83	13.7
16-20 Years	19	6.9	81	13.3
21+ Years	132	48.5	332	54.5

TABLE IV

Summary of Group A Streptococcus Positive Pets From Households With Human Streptococcal Infection (Index Households).

Age	Sex ¹	Breed	Number of Pets In Household	Illness In Pets	Number of People In Household	Number of Children <16 Yrs In Household
11 Years	F	Dachshund	2 ²	Coughing	4	2
9 Weeks	M	Shetland Sheepdog	1	None	4	2
4 Years	M	Mixed	2 ²	None	4	2

1. M = Intact Male, F = Intact Female.

2. Both households had 2 pets, 1 dog and 1 cat, the dogs were positive for Group A Streptococcus while the cats were both negative.

TABLE V

Summary of Pets Positive for Group A Streptococcus
From Comparison Households.

Age	Sex ¹	Breed	Number of Pets In Household	Illness In Pets	Number of People In Household	Number of Children <16 Yrs In Household
4 Months	M	Mixed	1	None	4	0
4 Years	M/C	Domestic Cat	1	None	3	0
2 Years	M	Miniature Schnauzer	1	None	4	0
4 Months	F	Mixed	1	None	4	1
4 ² Years	M	Miniature Schnauzer	2	None	4	2
2 ² Years	F	Miniature Schnauzer	2	None	4	2

1. M = Intact Male, M/C = Castrated Male,
F = Intact Female

2. Both dogs were from the same household, both
were positive for Group A Streptococcus.

TABLE VI

Summary of Data of Pets From Households With Human Group A Streptococcus Infection (Index Households) and From Comparison Households.

	Streptococcus Positive (Index) Households	Comparison Households
Total Animals Sampled	104	220
Clinical Histories Completed	86 (82.6%)	220 (100%)
Number of Households	80	180
Number of Households Completing Clinical History	62 (77.5%)	180 (100%)
Number of Pets Positive for Group A <u>Streptococcus</u>	3 (2.8%)	6 (2.7%)
Number of Dogs/Cats	77/27 (74%/26%)	162/58 (74%/26%)
Number of Male/Female	41/45 (47.5%/52.5%) ¹	112/108 (50%/50%)
Mean Age of Pets	4.15 ± 3.17 Years ¹	4.1 ± 3.3 Years
Mean Number of Pets per Household	1.5 ± 0.68 ¹	1.65 ± 1.0
Mean Number of People per Household	4.33 ± 1.13 ¹	3.6 ± 1.57

1. Data represents only that data which was gained from completed clinical histories.

TABLE VII

Comparison of Results Obtained at the Laboratory, USAF Medical Center, Wright - Patterson Air Force Base and the Department of Veterinary Preventive Medicine, Ohio State University on Samples Submitted for Bacterial Isolation of Group A Streptococcus.

Sample Number	Species	USAF Medical Center	Department of Veterinary Preventive Medicine
1 ¹	Human	Group A <u>Streptococcus</u>	Group A <u>Streptococcus</u>
2 ¹	Human	Negative	Negative
45 ^{2,4}	Canine	Negative	Group A <u>Streptococcus</u>
48 ³	Canine	Negative	Negative
49 ³	Canine	Negative	Negative
29 ³	Canine	Negative	Negative
39 ³	Canine	Negative	Negative
46 ^{2,4}	Canine	Negative	Group A <u>Streptococcus</u>
105 ³	Canine	Negative	Negative
219 ^{2,4}	Canine	Negative	Group A <u>Streptococcus</u>

1. Original isolation attempts at the Laboratory USAF Medical Center.
2. Original isolation attempts at the Department of Veterinary Preventive Medicine, OSU.
3. Paired samples submitted to both laboratories.
4. Samples identified as positive for Group A Streptococcus at the Department of Veterinary Preventive Medicine.

DISCUSSION

The purpose of this study was to determine if there was an increased prevalence of isolation of Group A Streptococcus in pets from families with streptococcal disease as compared to pets from families free from streptococcal disease. In this study, there was no statistical difference in the prevalence rates, based upon isolation, of Group A Streptococcus for either group of animals. The prevalence of isolation of Group A Streptococcus in this study was within the range reported by Peterson (1%), Kurek and Rutkowiak (7%), and Clapper and Meade (9%) for pets (Peterson, Kurek and Rutkowiak) and for laboratory colony dogs (Clapper and Meade). (49,27,6)

The inference has been made by Peterson that pets from households where there is streptococcal disease might act as a source of infection or re-infection for family members. (49) The results of this study cannot prove or disprove this hypothesis. However, the nearly equal prevalence in both index and comparison households suggests that it is unlikely that the pet would play a major role in the maintenance of streptococcal disease within the family group.

It is commonly accepted that the major source of streptococcal upper respiratory tract infection in human beings is other human beings. (55) In addition, not all households in which there is streptococcal upper respiratory tract infection will have a family pet, thus limiting the role that the pet can play in the transmission of Group A Streptococcus within family groups. If the family pet does serve as a source of infection, the magnitude of zoonotic transmission would be very small in comparison with person to person transmission. Because of the limitations of the present study, the sample size may not have been large enough to reveal a significant association between Group A streptococcal isolation in family pets and Group A streptococcal infection in the family if, in fact, one does exist.

A possible source of Group A Streptococcus in the pets from the comparison households would be human asymptomatic carriers. The reported carrier rates of Group A streptococci vary widely, but a generally accepted figure is around 10%. (41) Due to the limitations of this study it was not possible to determine the carrier status of the individual human beings in the comparison households. Thus the effects of human asymptomatic carriers upon the results of comparison households can not be determined.

Differences in the index and comparison households could have biased the results of the isolation rate of Group A Streptococcus in this study. Index households were significantly larger than comparison households ($p < 0.05$). The larger index household could have provided more sources for exposure of their pets to Group A Streptococcus. (9) If human to animal transmission does occur, this would have resulted in an increased prevalence of isolation of Group A Streptococcus, which was not observed in this study. Index households also had a significantly larger proportion of the household population under 16 years of age than did the comparison households ($p < 0.005$). The peak of streptococcal prevalence in humans occurs between the fourth and twelfth years of life. (24,67) The larger percentage of household members in this age group could have provided an increased opportunity for pet exposure to Group A Streptococcus with a resulting increase in the prevalence of isolations. However, the increased exposure to the most likely carriers of Group A Streptococcus (i.e. children) did not appear to cause an increase in the prevalence of isolation from dogs. There was a slight, but not significant, difference in the species and sex distribution of the pets from index and comparison households ($0.05 < p < 0.1$). In human beings sex seems to have little effect

upon the carrier state of β -hemolytic streptococci, and in the studies of isolations of β -hemolytic streptococci in animals sex was not noted to be a factor in the rate of isolation. (3,52) The number of pets in index and comparison households was different, but not significant ($0.05 < p < 0.1$); the comparison households having more pets. If the dog is capable of transmitting Group A Streptococcus, households with more pets would provide a greater opportunity for transmission between pets and between people and pets. Only one comparison household from which Group A Streptococcus was isolated had 2 pets; these were both positive for Group A Streptococcus. In the index households from which Group A Streptococcus was isolated there were two households with 2 pets (both had 1 dog and 1 cat). In these households the dogs were both positive while the cats were negative. The effect of the number of pets in the household upon the prevalence of isolation of Group A Streptococcus is difficult to determine with the small number of isolates of Group A Streptococcus in this study.

Two different types of bacitracin disks were used for the identification of Group A Streptococcus in the comparison pets. Different disks were also used to identify the streptococcal isolates from the index and

comparison households. Most of the identification of Group A Streptococcus in the comparison group occurred using Difco disks (5/6). The Laboratory, USAF Medical Center, W-P AFB used Taxo A disks exclusively for the identification of Group A Streptococcus in the swabs submitted from the index household pets. The Maxted method for the identification of Group A Streptococcus is not totally accurate in that an occasional false negative result occurs even under ideal conditions and false positives also occur. The majority of the false positives are the identification of Lancefield's Groups B, C, and G as Group A. These false positives occur in 4% to 8% of the total isolations of Group A. (4,42,44) The results using different manufacturer's disks (g.,h.) does not appear to vary widely in total false reactions, the range being around 6% to 8%. (4,42) Because the total identification rate for the two different disks is not greatly different the use of the two different products is thought not to effect the results of this study.

Correlation of Group A Streptococcus positive results between the Laboratory, USAF Medical Center,

g. Bacto Differentiation Disks-Bacitracin , Difco.
h. Taxo A , BBL

W-P AFB and those results obtained at the Department of Veterinary Preventive Medicine during this study was not satisfactory. All 3 of the Group A Streptococcus positive samples submitted to the Laboratory, USAF Medical Center were identified as negative. Two of the swabs which were identified as positive at the Department of Veterinary Preventive Medicine and later identified as negative at the Laboratory, USAF Medical Center, W-P AFB had prolonged transit times (48 hours) which could have resulted in the failure of the latter to isolate and identify the Group A Streptococcus. The third swab was first reported as missing by the Laboratory, USAF Medical Center, W-P AFB and then later reported as negative. These events could have led to a decreased number of viable streptococci and a reduced ability to identify the Group A Streptococcus.

Based on the results of this study, it appears that the prevalence of isolation of Group A Streptococcus from pets is not governed by the presence of streptococcal disease in the family. To study the role that the family pet might play in the transmission of Group A Streptococcus a study of different design might prove helpful. Using matched pairs of index and comparison households would provide better control of the characteristics which might influence the rate of

isolation of Group A Streptococcus. During this study it was not possible to estimate the percentage of households who were asked to bring their animals to the Base Veterinary Services, W-P AFB for an attempted isolation of Group A Streptococcus which eventually did, or the length of time which elapsed between the initial contact and the actual culturing of the animal. In a more definitive study all households where Group A Streptococcus was isolated from people should be used as the index group and all should be cultured as soon as possible after initial isolation of Group A Streptococcus in the household. The culturing of all family members and all pets in each index and comparison household would provide more evidence of the prevalence of Group A Streptococcus in the entire study population.

The techniques used for culture and isolation of Group A Streptococcus in this study were dependent on the procedures used in the Laboratory, USAF Medical Center. Although they are acceptable for the diagnosis of streptococcal disease, they do not always result in the detection of Group A Streptococcus due to the following factors: lack of sufficient colonies on the plate, overgrowth of the normal flora of the oropharynx, or the zone of inhibition around the bacitracin disk being absent. (44,62,66,74) Because of these factors

sub-culturing β -hemolytic colonies and using the bacitracin disks as an initial method of determination of the group of streptococci to which the isolate belonged would provide more accurate data on the prevalence of Group A Streptococcus in pets. The same type of results could be achieved using enrichment media selective for the streptococci such as Edward's or Pike's and using Maxted's method on the isolate of streptococci obtained by this method. (12,51) All isolates of streptococci should be grouped serologically to confirm the Lancefield's group. After Lancefield's grouping the isolates should be typed so the identification of strains isolated from pets and household members can be compared. By using the M and T antigens as "finger prints" for the isolates it would be possible to determine if the Group A Streptococcus which inhabits the oro-pharynx of the human members of the household is also the type which inhabits the oro-pharynx of the pets. This type of study would provide more complete evidence on the epidemiological patterns of streptococcal distribution between human beings and their pets.

SUMMARY

The purpose of this study was to determine if there was an increased prevalence, based on bacterial isolation, of Group A Streptococcus in pets from households with streptococcal upper respiratory tract disease as compared to households without streptococcal disease. Eighty households in which upper respiratory tract disease due to Group A Streptococcus had been diagnosed in one or more household members were studied. One hundred four pets from these 80 households were bacteriologically examined and the prevalence of Group A Streptococcus was 2.88% (3/104). Two hundred twenty pets representing 180 comparison households were used for the comparison group; the prevalence of Group A Streptococcus in these animals was 2.72% (6/220). There was no statistical difference between the prevalence rate of Group A Streptococcus in these two groups of pets. Although these results did not reveal a significant association between Group A Streptococcus in man and pets in the same household, it can not be concluded that the family pet does not serve as one of the possible sources of Group A Streptococcus in human beings.

BIBLIOGRAPHY

1. Ado, A.D., Titova, S.M.: A Study of Experimental Influenza in Dogs. *Vopr. Virusol.*, 4, (1959): 36 - 41.
2. Binn, L.N., Lazar, E.C., Rogul, M., Shepler, V., Swango, L.J., Claypoole, T., Hubbard, D.W., Asbill, S.G., Alexander, A.D.: Upper Respiratory Disease in Military Dogs: Bacterial, Mycoplasma, and Viral Studies. *Am. J. Vet. Res.*, 29, (1968): 1809 - 1815.
3. Brennan, P.C., Simkins, R.C.: Throat Flora of a Closed Colony of Beagles. *Proc. Soc. Exp. Bio. Med.*, 134, (1970): 566 - 570.
4. Chitwood, L.A., Jennings, M.B., Riley, H.D.: Time, Cost, and Efficacy Study of Identifying Group A Streptococci with Commercially Available Reagents. *Appl. Microbiol.*, 18, (1969): 193 - 197.
5. Chrisman, C.L.: Diseases of the Peripheral Nerves and Muscles. In Textbook of Veterinary Internal Medicine. Edited by S.J. Ettinger. W.B. Saunders, Philadelphia, Pa., (1975): 459 - 494.
6. Clapper, W.E., Meade, G.H.: Normal Flora of the Nose, Throat, and Lower Intestine of Dogs. *J. Bacteriol.*, 85, (1963): 643 - 648.

7. Cornfeld, D., Hubbard, J.P.: A Four Year Study of the Occurrence of Beta-Hemolytic Streptococci in 64 School Children. N. Eng. J. Med., 264, (1961): 211 - 215.
8. Dochez, A.R., Avery, O.T., Lancefield, R.C.: Studies on the Biology of Streptococcus. I. Antigenic Relationships Between Strains of Streptococcus hemolyticus. J. Exp. Med., 30, (1919): 179 - 213.
9. Dunlap, M.B., Harvey, H.S.: Multiple Types of Streptococci in the Home. Am. J. Dis. Child., 107, (1964): 85 - 91.
10. Edwards, E.A., Larson, G.L.: Serological Grouping of Hemolytic Streptococci by Counter-immunoelectrophoresis. Appl. Microbiol., 26, (1973): 889 - 903.
11. Edwards, E.A., Larson, G.L.: New Method of Grouping Beta-Hemolytic Streptococci Directly on Sheep Blood Agar Plates by Co-agglutination of Specifically Sensitized Protein A Containing Staphylococci. Appl. Microbiol., 28, (1974): 972 - 976.
12. Edwards, S.J.: Studies of Bovine Mastitis: Selective Medium for Diagnosis of Streptococcus Mastitis. J. Comp. Path. Therap., 46, (1933): 211 - 217.

13. Ettinger, S.J., Suter, P.F.: Canine Cardiology.
W.B. Saunders, Philadelphia, Pa., (1975).
14. Fluharty, D.M.: Streptococcosis. In Diseases Transmitted from Animals to Man, Sixth Edition.
Edited by Hubbert, W.T., McCulloch, W.F., and Schnurrenburger, P.R.. Charles C. Thomas, Springfield, Ill., (1975): 298 - 302.
15. Frank, P.F., Stollerman, G.H., Miller, L.F.:
Protection of a Military Population from Rheumatic Fever: Routine Administration of Benzathine Penicillin G to Healthy Individuals. J. Am. Med. Assoc., 193, (1965): 775 - 783.
16. Greiner, T.P., Betts, C.W.: Diseases of the Prostate Gland. In Textbook of Veterinary Internal Medicine. Edited by S.J. Ettinger. W.B. Saunders, Philadelphia, Pa., (1975): 1274 - 1306.
17. Griffith, F.: Types of Hemolytic Streptococci in Relation to Scarlet Fever. J. Hyg., 25, (1926): 385 - 397.
18. Griffith, F.: Types of Hemolytic Streptococci in Relation to Scarlet Fever (Second Report). J. Hyg., 26, (1927): 363 - 373.

19. Griffith, F.: The Serological Classification of Streptococcus pyogenes. J. Hyg., 34, (1934): 542 - 584.
20. Hamburger, M., Green, M.J., Hamburger, V.G.: The Problem of the "Dangerous Carrier" of Hemolytic Streptococci. I. Number of Hemolytic Streptococci Expelled by Carriers with Positive and Negative Nose Cultures. J. Infect. Dis., 77, (1945): 68 - 71.
21. Hamburger, M., Green, M.J., Hamburger, V.G.: The Problem of the "Dangerous Carrier" of Hemolytic Streptococci. II. Spread of Infection by Individuals with Strongly Positive Nose Cultures Who Expelled Large Numbers of Hemolytic Streptococci. J. Infect. Dis., 77, (1945): 96 - 108.
22. Hare T., Fry, R.M.: Preliminary Observations of an Infection of Dogs by Beta-Hemolytic Streptococci. Vet. Rec., 50, (1938): 213 - 218.
23. Hare, T., Fry, R.M.: Papers Presented to Congress N.V.M.A. #6. Clinical Observations of the Beta-Hemolytic Streptococcal Infection of Dogs. Vet. Rec., 50, (1938): 1537 - 1548.
24. Harvey, H.S., Dunlap, M.B.: Carrier State in Relationship to Streptococcal Disease. Am. J. Dis. Child., 107, (1964): 240 - 246.

25. Krause, R.M., Rammelkamp, C.H., Denny, F.W., Wannamaker, L.W.: Studies of the Carrier State Following Infection with Group A Streptococci. I. Effect of Climate. J. Clin. Invest., 41, (1962): 568 - 574.
26. Krause, R.M., Rammelkamp, C.H.: Studies of the Carrier State Following Infection with Group A Streptococci. II. Infectivity of Streptococci Isolated During Acute Pharyngitis and During the Carrier State. J. Clin. Invest., 41, (1962): 575 - 578.
27. Kurek, C., Rutkowiak, B.: Dog Carriers of Streptococcus pyogenes on the Mucous Membranes of the Tonsils. Epidemiol. Rev., 25, (1971): 234 - 238.
28. Lancefield, R.C.: The Antigenic Complex of Streptococcus hemolyticus. I. Demonstration of a Type Specific Substance in Extracts of Streptococcus hemolyticus. J. Exp. Med., 47, (1928): 91 - 103.
29. Lancefield, R.C.: A Serological Differentiation of Human and Other Groups of Hemolytic Streptococci. J. Exp. Med., 57, (1933): 571 - 595.

30. Lancefield, R.C.: A Micro-precipitin Technic for Classifying Hemolytic Streptococci, and Improved Methods for Producing Antisera. Proc. Soc. Exp. Biol. Med., 38, (1938): 473 - 478.
31. Lancefield, R.C.: Type Specific Antigens, M and T, of Matt and Glossy Variants of Group A Hemolytic Streptococci. J. Exp. Med., 71, (1940): 521 - 537.
32. Lancefield, R.C., Pearlman, L.E.: Preparation and Properties of a Protein (R Antigen) Occurring in Streptococci of Group A, Type 28, and in Certain Streptococci of Other Serological Groups. J. Exp. Med., 96, (1952): 83 - 97.
33. Laughton, N.: Canine Beta-Hemolytic Streptococci. J. Path. Bact., 60, (1948): 471 - 476.
34. Lundgren, D.L., Magnuson, M.G., Clapper, W.E.: A Serologic Survey in Dogs for Antibody to Human Respiratory Viruses. Lab. Anim. Care, 19, (1969): 352 - 359.
35. Mantovani, A., Restani, R., Sciarra, D., Simonella, P.: Streptococcus L Infection in the Dog. J. Small Anim. Pract., 2, (1961): 185 - 194.
36. Maxted, W.R.: The Use of Bacitracin for Identifying Group A Hemolytic Streptococci. J. Clin. Path., 6, (1953): 223 - 226.
37. Maxted, W.R., Widdowson, J.P.: The Protein

- Antigens of Group A Streptococci. In Streptococci and Streptococcal Diseases: Understanding, Recognition, Management. Edited by L.W. Wannamaker and J.M. Matsen. Academic Press, New York, N.Y., (1972): 251 - 266.
38. McCarty, M.: Streptococcal Infections. Columbia University Press, New York, N.Y., (1954).
39. McCarty, M.: The Hemolytic Streptococci. In Bacterial and Mycotic Infection of Man. Edited by R. Dubos and J. Hirsch. J.B. Lippencott, Philadelphia, Pa., (1965): 356 - 389.
40. McCarty, M.: The Streptococcal Cell Wall. The Harvey Lectures, 65, (1971): 73 - 96.
41. McCarty, M.: Streptococci. In Microbiology. Edited by Davis, B.D., Dulbecco, R., Eisen, H.N., Ginsberg, H.S., Wood, W.B.. Medical Department, Harper and Row, Hagerstown, Md., (1973): 708 - 726.
42. Moody, M.D.: Old and New Techniques for Rapid Identification of Group A Streptococci. In Streptococci and Streptococcal Diseases: Understanding, Recognition, Management. Edited by L.W. Wannamaker and J.M. Matsen. Academic Press, New York, N.Y., (1972): 172 - 188.

43. Moody, M.D., Ellis, E.C., Updyke, E.L.: Staining Bacterial Smears with Fluorescent Antibody. IV. Grouping Streptococci with Fluorescent Antibody. J. Bacteriol., 75, (1958): 553 - 560.
44. Murray, P.R., Wold, A.D., Hall, M.M., Washington, J.A.: Bacitracin Differentiation for Presumptive Identification of Group A Beta-Hemolytic Streptococci: Comparison of Primary and Purified Plate Testing. J. Pediat., 89, (1976): 576 - 579.
45. Nicholas, W.C., Steele, C.P.: Occurrence of Groupable Beta-Hemolytic Streptococci: Study Among School Children in Bismark N.D.. J. Am. Med. Assoc., 181, (1962): 197 - 205.
46. Osborne, C.A., Low, D.G., Finco, D.R.: Canine and Feline Urology. W.B. Saunders, Philadelphia, Pa., (1972).
47. Perry, W.D., Siegel, A.C., Rammelkamp, C.H., Wannamaker, L.W., Marple, E.C.: Transmission of Group A Streptococci. I. The Role of Contaminated Bedding. Am. J. Hyg., 66, (1957): 85 - 95.
48. Perry, W.D., Siegel, A.C., Rammelkamp, C.H.: Transmission of Group A Streptococci. II. The Role of Contaminated Dust. Am. J. Hyg., 66, (1957): 96 - 101.
49. Peterson, M.R.: Strep Infection: Your Pet May

- Have It Too. USAF Medical Service Digest, 27,
(1976): 21.
50. Phibbs, B., Taylor, J., Zimmerman, R.A.: A
Community Wide Streptococcal Control Project, The
Natrona County Primary Prevention Program, Casper,
Wyo.. J. Am. Med. Assoc., 214, (1970):
2018 - 2024.
51. Pike, R.M.: The Isolation of Hemolytic Streptococci
from Throat Swabs. Experiments with Sodium Azide
and Crystal Violet in Enrichment Broth. Am. J. Hyg.,
41, (1945): 211 - 220.
52. Pike, R.M., Fashena, G.J.: Frequency of Hemolytic
Streptococci in Throats of Well Children in
Dallas. Am. J. Pub. Hlth., 36, (1946): 611 - 622.
53. Pilot, I., Buck, C., Davis, J.A., Eastman, D.A.:
Tonsillitis in Dogs due to Hemolytic Streptococci.
Proc. Soc. Exp. Biol. Med., 34, (1936): 499 - 502.
54. Quinn, R.W.: Carrier Rates for Hemolytic
Streptococci in School Children, A Six Year Study.
Am. J. Epidemiol., 82, (1965): 1 - 13.
55. Rammelkamp, C.H.: Epidemiology of Streptococcal
Infections. The Harvey Lectures, 51, (1957):
113 - 142.
56. Rammelkamp, C.H., Top, F.H.: Streptococcal
Infections. In Communicable and Infectious

- Diseases. Edited by F.H. Top and P.F. Wehrle.
The C.V. Mosby Co., St. Louis, Mo., (1972):
630 - 647.
57. Rantz, L.A., Randall, E.: Use of Autoclaved
Extracts of Hemolytic Streptococci for Serological
Grouping. Stanford Medical Bulletin, 13, (1955):
290 - 291.
58. Rosan, B.: Analytical Serology of Streptococci and
Lactobacilli. In Analytical Serology of
Microorganisms. Edited by J.B.G. Kwapinski.
Interscience Publishers, New York, N.Y., (1969):
425 - 484.
59. Schottmüller, H.: Die Artunterscheidung dur
Fürden Menschen Pathogenen Streptokokken Durch
Blutager. München Med. Wschr., 50, (1903):
840 - 853, 909 - 912.
60. Skjold, S.A., Wannamaker, L.W.: Method for Phage
Typing Group A Type 49 Streptococci. J. Clin.
Micro., 4, (1976): 232 - 238.
61. Smith, J.E.: The Aerobic Bacteria of the Nose
and Tonsils of Healthy Dogs. J. Comp. Path., 71,
(1961): 428 - 433.
62. Sprunt, K., Vail, D., Asnes, R.S.: Identification
of Streptococcus pyogenes in a Pediatrics Out-
patient Department: A Practical System Designed

- for Rapid Results and Resident Training. *Pediatrics*, 54, (1974): 718 - 723.
63. Srisuparbh, K., Sawyer, W.D.: Effect of Exposure to the Atmosphere on the Infectivity of Group A Streptococci. *Infect. Immun.*, 5, (1972): 176 - 179.
64. Stableforth, A.W.: Streptococcus Infections of Animals and Their Treatment. *Vet. Rec.*, 50, (1938): 1203 - 1214.
65. Stafseth, H.J.: Streptococcic Infections of Dogs. II. Pathogenicity, "Acid Milk", Convulsions, Tonsillitis, Abscesses, Conjunctivitis, and Skin Contamination. *J. Am. Vet. Med. Assoc.*, 96, (1940): 230 - 235.
66. Streamer, C.W., Williams, P.M., Wang, W.W.L., Johnson, R.S., McGuire, C.D., Abelow, I.J., Glaser, R.J.: Bacitracin Disk and Fluorescent Antibody Techniques Compared with the Lancefield Precipitin Method. *Am. J. Dis. Child.*, 104, (1962): 157 - 160.
67. Streitfield, M.M., Saslaw, M.S.: Correlation of Population Age with Recovery Rates of β -Hemolytic Streptococci and Serological Responses. *J. Infect. Dis.*, 108, (1961): 270 - 277.
68. Suter, P.F., Head, J.R.: Mediastinal, Pleural, and Extrapleural Diseases. In Textbook of Veterinary Internal Medicine. Edited by S.J.

- Ettinger. W.B. Saunders, Philadelphia, Pa.,
(1975): 767 - 806.
69. Swift, H.F., Wilson, A.T., Lancefield, R.C.:
Typing Group A Hemolytic Streptococci by M
Precipitin Reactions in Capillary Tubes.
J. Exp. Med., 78, (1943): 127 - 133.
70. Todd, J.D., Cohen, D.: Studies of Influenza in
Dogs. I. Susceptibility of Dogs to Natural and
Experimental Infection with Human A2 and B Strains
of Influenza Virus. Am. J. Epidemiol., 87, (1968):
426 - 439.
71. Wannamaker, L.W.: The Epidemiology of
Streptococcal Infections. In Streptococcal
Infections. Edited by M. McCarty. Columbia
University Press, New York, N.Y., (1954):
157 - 175.
72. Wannamaker, L.W., Matsen, J.M.: Streptococci
and Streptococcal Diseases: Understanding,
Recognition, Management. Academic Press, New York,
N.Y., (1972).
73. Wilkens, B.J., Helland, D.R.: Antibacterial
Sensitivities of Bacteria Isolated from Dogs with
Tracheobronchitis. J. Am. Vet. Med. Assoc., 162,
(1973): 47 - 50.

74. Williams, R.E.O.: Laboratory Diagnosis of Streptococcal Infections. Bull. Wld. Hlth. Org., 19, (1958): 153 - 176.
75. Youmans, G.P., Paterson, P.Y., Sommers, H.M.: The Biologic and Clinical Basis of Infectious Diseases. W.B. Saunders, Philadelphia, Pa., (1975): 172 - 185.

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